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Seminar 55 - Best Practices for Evaluating and Improving the Performance of Commercial Buildings

A working guide that provides tools and techniques for improving the acoustic performance of a facility.

Seminar 55- Learning Objectives

- 1. Explain the meaning of acoustic comfort in occupied buildings for assorted uses, as well as why acoustic comfort is an important aspect of a building's Indoor Environmental Quality (IEQ)
- 2. Describe recent advances related to acoustic comfort in standards and green rating systems for high performance buildings
- 3. Apply the basic, diagnostic, and analysis procedures listed in the ASHRAE Best Practices Guide to evaluate building acoustic performance
- 4. Apply green building design methodologies appropriately to complement acoustics

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Outline

- The challenge of benchmarking building performance.
- ASHRAE's response to this challenge
- Added challenges related to IEQ Acoustics.
- Tools for evaluating and improving building acoustics that are in the Performance Measurement Protocol-Best Practices Guide.

The Challenge

- Substantiate claims of building performance.
- Facilitate appropriate and repeatable benchmarking of measured performance.
- Assure that improved energy and water efficiency does not degrade building IEQ.
- Provide feedback to building designers and operators for continuous improvement.

The Response

Two ASHRAE Publications

- Performance Measurement Protocols for Commercials Buildings (2010) – with CIBSE and USGBC
- Performance Measurement Protocols for Commercial Buildings, Best Practices Guide (2012) – with CIBSE

Best Practices Guide (2012)

... gives building owners and their consultants the practical performance management guidance to meet market demands for keeping operating costs down without sacrificing the health, comfort and productivity of the highest cost component - the building's occupants.



Users

The primary users of this guide:

- Facility managers
- Building operators (the O&M team)
- Commissioning authorities (CA)
- Tenants
- Green building raters
- Energy Services Companies
- Architects and design engineers

Measurements

As in the original PMP document, this Best Practices Guide covers the six measurement categories of:

- Energy use
- Water use
- IEQ Thermal comfort
- IEQ Indoor air quality (IAQ)
- IEQ Lighting
- IEQ Acoustics.

The Need for Good Acoustics

- Of all the IEQ factors surveyed in over 500 buildings by the CBE, the one causing the greatest occupant dissatisfaction is acoustics, including both noise level and speech privacy issues.¹
- 85% of employees were dissatisfied with their office environment and were struggling to concentrate.²
- Employees on average waste 86 minutes per day due to conversational distractions (18% loss in productivity).²

Occupant Satisfaction - Acoustics



CBE survey on 351 bldg. and 52,980 occupants. Frontczak M, Schiavon S, et al. 2011

Performance Levels - Acoustics

Basic (Ch. 2)

- Walk-through Observations
- Building Maintenance Log
- Occupant Survey such as CBE

Diagnostic (Ch. 3)

- Leq (dBA)
- Reverberation Time Calculation
- Simplified Speech Privacy (sidebar)

Advanced Analysis (Ch. 4)

• Consultant: NC, T₆₀, air-borne and structureborne isolation.

Basic - Occupant Survey

- Walk though checklist (Appendix A-8)
- Occupant IEQ Survey from Center for Built Environment (CBE) for four major categories of IEQ³
- Building Use Studies (BUS) survey⁴
- Both CBE and BUS surveys have large databases of accumulated results that serve as benchmarks against which occupants' responses can be evaluated.

Walk-through Checklist

- Checklist of Issues in the form of questions?
- Recommended Corrective Actions
- Categories
 - Background Noise
 - Noise intrusion
 - Acoustic Privacy
 - Speech Communication

	IE	Q Acoust	ics					
Category	Issue	Photo ID Space ID		Recommended Corrective Actions				
kground Noise	Is the mechanical equipment (heating, cooling and ventilation) noise unacceptable?			Verify that the HVAC system and controls are operating as designed and that the equipment is properly maintained. If so, proceed to Diagnostic Measurement and/or Advanced Analysis levels.				
	Is the noise from the office equipment unacceptable (telephones, copiers,)?			Replace noisy office equipment with quieter models. Consider moving noisy equipment to more isolated areas.				
	Is the noise from the lighting unacceptable?			Establish a program for reporting noisy light fixtures and quickly replace ballasts.				
Bac	Can you hear plumbing noise?			Proceed to Diagnostic Measurement and/or Advanced Analysis levels.				
	Does the background noise vary significantly with the time of day or season?			Proceed to Diagnostic Measurementand/or Advanced Analysis levels.				
	Are you startled or disturbed by the intrusion of noise from other rooms?			Proceed to Diagnostic Measurement and/or Advanced Analysis levels				
usion	Can you hear noise from adjacent rooms through the wall, ceiling or ductwork?			For rooms with ceiling tile systems, select tiles with high sound transmission loss, extend interposing wall to ceiling deck and sea				
Noise Intri	Are you disturbed by footfall noise from the floor above?			Add carpet to the floor above. If this corrective action is not adequate, then proceed to the Diagnostic Measurement and/or Advanced Analysis levels.				
	Can you hear noise from the outside through the wall, windows or ventilation openings?			Proceed to Diagnostic Measurement and/or AA levels.				
A coustic Privacy	Does sound privacy in your workplace interfere with employees getting their job done?		_	Proceed to Diagnostic Measurement and/or Advanced Analysis levels.				
	Can you overhear other people talking on the phone from one workspace to another?			Establish a training program on telephone etiquette or introduce new telephone equipment with headset and quiet signaling features. If these "personal" corrective actions are not adequate, then proceed to the Diagnostic Measurement level.				
	Can you overhear private conversations from neighboring areas or offices?			Designate acoustically isolated spaces for private conversations. If these "personal" corrective actions are not adequate, then				
Speech Communication	Is it difficult to understand or hear speech in meeting rooms or lecture halls?			Proceed to Diagnostic Measurement and/or Advanced Analysis levels.				
	To communicate in the space do you have to raise your voice?			Proceed to Diagnostic Measurementand/or Advanced Analysis levels.				
	Does the background noise interfere with speech communication?			Proceed to Diagnostic Measurement and/or Advanced Analysis levels.				
	Is speech difficult to understand because of echoing of voices and other sounds?			Add sound absorptive furnishings and/or sound absorptive materials to the room surfaces, for example, an acoustical ceiling				
	Does the sound persist when you clap your hands?			See above corrective actions.				

Example – CBE Acoustic Survey

Acoustic Quality

How satisfied are you with the noise level in your workspace?

Very Satisfied 🖾 0000000 🖏 Very Dissatisfied

How satisfied are you with the sound privacy in your workspace (ability to have conversations without your neighbors overhearing and vice versa)?

Very Satisfied 🚰 000000 🖏 Very Dissatisfied

Overall, does the acoustic quality in your workspace enhance or interfere with your ability to get your job done?

Enhances 🖾 000000 🕬 Interferes

You have said you are dissatisfied with the acoustics in your workspace. Which of the following contribute to this problem? (check all that apply)
People talking in neighboring areas
People overhearing my private conversations
Office equipment noise
Office lighting noise
Telephones ringing
Mechanical (heating, cooling and ventilation systems) noise
Excessive echoing of voices or other sounds
Outdoor traffic noise
Other outdoor noise
Other:

Please describe any other issues related to acoustics that are important to you.

Example of Benchmarking



Mixed Mode Buildings (n=12)

CBE Database (n= 358)

Diagnostic Measurements (dBA)

Diagnostic Measurement Worksheet - IEQ Acoustics Office Building Example							EXCE	RPTS
Name of Building: Address: City/State/Zip: Date: Data collected by:		XYZ Supply Company 123 Central Blvd. San Diego, CA 2/2/2012 Jason Smith		Ben	chmarl	KS		
Room Use (Menu)			Criteria	ı (Benchm	Measurements			
Room Number	Wing/Zone	Number of occupants	Room Type/Activity	Leq dB(A) Ideal	Leq dB(A) Max.	T ₆₀ (secs)	Measured Leq dB(A)	Estimated T ₆₀ (secs)
2nd floor	North-East	32	Open-plan office	45	50	< 0.8	40 - 50	0.6
201	North-East	15 max	Conference room	35	45	< 0.6	46	0.3
203	North-East	15 max	Conference room	35	45	< 0.6	35	0.3
205	North-East	15 max	Conference room	35	45	< 0.6	38	0.3
207	North-East	25 max	Video-Teleconference room	30	35	< 0.6	32	0.4
202	North-East	1	Private office	35	45	< 0.6	32	-
204	North-East	1	Private office	35	45	< 0.6	38	-
206	North-East	1	Private office	35	45	< 0.6	36	-
208	North-East	1	HR meeting room	35	45	< 0.6	35	-
Lobby	Ground floor	n/a	Lobby	45	55	n/a	48	0.7

Reverberation Calculations (T₆₀)

Reverberation Time (T ₆₀) Calculation									
Location Buchannan HS, Room 201 (all rooms on 1st and 2nd floor are similar)									
Room Size and Length Width Area	Volume 50 20 1000	ft CLA ft sq-ft	CLASSROOM EXAMPLE						
Ceiling Height	10	ft							
Volume 10000 cu-ft									
Surface Materia	als								
	Area	Material		50	500	1000	2000	4000	
Floor	1000	Floor, Carpet (thin, on concrete)	0.	06	0.12	0.40	0.42	0.58	
Wall 1	500	Walls, Concrete block, painted	0.	05	0.06	0.07	0.09	0.08	
Wall 2	500	Walls, Glass, 1/4" heavy plate	0.	06	0.04	0.06	0.02	0.02	
Wall 3	200	Walls, Concrete block painted	0.	05	0.06	0.07	0.09	0.08	
Wall 4	200	Walls, Concrete block painted	0.	05	0.06	0.07	0.09	0.08	
Ceiling	1000	Ceiling panels (Std. 5/8" mineral board)	0.	76	0.60	0.65	0.82	0.76	
Each unit									
Other Objects	48	Drapery, medium weigh, per sq-ft wall area	0.	31	0.49	0.70	0.65	0.60	
			I		L				
		Reverberation Time (T ₆₀ in sec)	0	.5	0.6	0.4	0.4	0.3	

Simplified Speech Privacy

"Young" calculation method (using A-weighting)



Example Calculation for Speech Privacy:

54 - 16 - 48 = -10 dBA (lower is better)

Reference: Charles M. Salter Associates

Advanced Analysis

- Will corrective actions lead to architectural or mechanical design changes?
- Recommendation is to hire an acoustical consultant.
- Guidance is provided on where to find and select a consultant.
- Example data sheets are provided in an informative appendix that illustrate more advanced analysis.

Summary

- The ASHRAE Performance Measurement Protocol Best Practices Guide provides simple and easy to use tools for evaluating and improving the acoustic performance of a commercial building.
- The cost savings from improving energy and water performance are far outweighed by the cost impact that IEQ has on occupant productivity and performance.
- The challenge for building performance improvement is to balance sustainability or "green" objectives with environmental qualities, such as acoustics.

Bibliography

- 1. Frontczak M, Schiavon S, et al. 2011. Indoor Air Journal.
- 2. Recent survey of 10,500 office workers in Europe, North America and Asia by office furniture retailer Steelcase and research firm IPSOS.
- CBE. 2008. Occupant Indoor Environmental Quality (IEQ) Survey[™]. <u>www.cbe</u>
- 4. The Building Use Studies (BUS) Occupant Survey by Usable Buildings Trust (UBT 2008).

Questions ?

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